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Plants for Insecticides and Rodenticides

by

A. F. Sievers

Senior Biochemist
Division of Drug and Related Plants
Bureau of Plant Industry, Soils and Agricultural Engineering
Agricultural Research Administration

and

E. C. Higbee

Agriculturist
Office of Foreign Agricultural Relations

OFFICE OF FOREIGN AGRICULTURAL RELATIONS
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PLANTS FOR INSECTICIDES AND RODENTICIDES

INTRODUCTION

Plants from many parts of the world contribute a number of efficient products for commercial use as insecticides and rodenticides. In some cases these products come from plants growing wild in such abundance that only their collection is necessary to supply the world demand. In others the plants are also grown as cultivated crops, and in still others the cultivated plant is depended upon entirely to furnish the quantities needed.

The plants discussed here as insecticides include a number that repel rather than kill insects, but they are included because repellents are of general interest in connection with insect control. Only two plant products are in commercial use as rodenticides.

The intention here is not to furnish complete information on these species but to describe them in reasonable detail with respect to their nature, climatic and cultural requirements, methods of harvesting required, and the commercial importance of their products in world trade. Such information should enable the reader to determine for himself whether a species is in general adapted to any particular region in which he is interested and whether its commercial introduction has possibilities.

The statistical information on imports of the various products by the United States was obtained from the United States Department of Commerce.[1] Production figures are given when available. Though imports by the United States do not indicate world consumption, they are of value to prospective producers in the Western Hemisphere, because they show the principal market outlet nearest the point of production.

Special references are cited which are believed to be sources of information of particular value to those who are primarily interested in the agricultural aspects of these plants.

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[1] UNITED STATES BUREAU OF FOREIGN AND DOMESTIC COMMERCE. FOREIGN COMMERCE AND NAVIGATION OF THE UNITED STATES. Compiled annually and published by the Government Printing Office, Washington, D. C.

ANABASIS

Botanical Source.- *Anabasis aphylla* L. Fam. Chenopodiaceae.

Range.- Russian Turkestan, the Caucasus, Transcaucasia, and adjoining regions of Turkey, Iran and Afghanistan, Morocco, Northern Algeria, Tunisia, Western Syria, and southern Palestine.

Nature of Plant.- Small woody perennial.

Part Used.- The alkaloid anabasine extracted from the entire aerial portion of the plant.

Commercial Uses, Sources, and Importance.- Anabasine is a contact insecticide in many respects similar to nicotine. It is usually used in the form of crude anabasine sulfate. It is produced commercially from *A. aphylla* in the Soviet Union. Anabasine has also been found in certain species of *Nicotiana*, particularly in *N. glauca*. A detailed discussion of this plant as a possible source of anabasine is included under the chapter on tobacco.

The anabasine used commercially is obtained from the wild plants in the Soviet Union. Actual production figures are not available. It is estimated that relatively large amounts of this insecticide could be produced annually in the Soviet Union from wild plants if their utilization for the purpose should become economically feasible.

Propagation and Culture.- The cultivation of *A. aphylla* has been practiced only on an experimental scale, and so far as known only in the Soviet Union. The regions where *A. aphylla* is found to have the highest content of anabasine have an annual rainfall of about 10 inches, and the temperature ranges from a mean of 30° to 35° F. in January to a mean of 75° to 80° F. in July. *A. aphylla* is found most extensively on saline soils with a high salty ground-water table to which the roots can penetrate.

In experimental plantings *A. aphylla* has been propagated by seed and vegetatively by root and stem cuttings. Planting must be made in the field in the fall or early spring so that the roots of the young plants will be established in moist subsoil before the approach of the dry hot summer season. Irrigation may be necessary the first year. The mature plant assumes a broad bushlike growth and reaches a height of 12 to 18 inches.

Harvest and Preparation for Market.- Commercially exploited fields of wild *A. aphylla* may be cut annually. The entire bushlike growth is cut off just above the ground. The crude anabasine and other alkaloids are obtained from the plant material in specially constructed central factories.

Yields.- Stands of wild *A. aphylla* are reported to produce an average of from 400 to 2,400 pounds of green plant material to the acre. Reports state that the anabasine content varies from about 1 percent in mature woody portions to 2 percent in young succulent growth, but they do not state whether these are calculated on the wet or dry basis. Only a trace is found in the roots, which consequently are not harvested.

References.-

[GREAT BRITAIN.] IMPERIAL INSTITUTE.
1940. A SURVEY OF INSECTICIDE MATERIALS OF VEGETABLE ORIGIN. 155 pp., illus. London.

ILIN, M. M.
1938. PROSPECTS FOR THE STUDY OF ANABASIS FROM THE ECONOMIC STANDPOINT. Acta Inst. Bot. Acad. Sci. U.S.S.R., Ser. V, Fasc. 1, 401-416, illus. [In Russian.]

ROARK, R. C.
1941. A REVIEW OF INFORMATION ON ANABASINE. U. S. Bur. Ent. and Plant. Quar. E-537, 55 pp. [Mimeographed.]

CEDARWOOD

Botanical Source.- *Juniperus virginiana* L. Fam. Pinaceae.

Range.- Canada to Florida and westward to the eastern slopes of the Rocky Mountains.

Nature of Plant.- Tree.

Part Used.- The red heartwood and the volatile oil obtained from it by distillation with steam.

Commercial Uses, Sources, and Importance.- Cedarwood oil, as it is known in the American market, has long been considered an effective repellent of the common clothes moth. This effect of the oil is the basis for the widespread use of chests and drawers made of or lined with red cedar and the cedar clothes closets in dwellings, all of which are provided to protect woolen cloth, clothes, and furs from moths. The belief is general that the vapors of the oil will kill the young larvae but cannot be relied upon to kill older larvae or adults or prevent the latter from laying eggs. The supplies of red-cedar lumber used for these purposes in the United States are obtained mainly in Virginia, North Carolina, and Tennessee. The cedarwood oil is produced from the sawdust and other wastes resulting from the manufacture of the red-cedar lumber, cedar chests, pencil slats, and other articles made from the wood. It is used mainly for scenting soaps. It has, however, been used to some extent for impregnating composition board or cardboard used for clothes closets or receptacles which are claimed to serve the same purpose as the cedarwood itself. Neither the cedarwood nor the oil is imported.

Harvesting and Preparation for Market.- The securing of the heartwood of the red cedar, the production of the lumber and veneer, and the manufacture of various articles therefrom is carried on mainly in the Southern Appalachian regions of the United States. From the waste wood the oil is distilled in some localities when it has sufficient market value. This is accomplished by the same equipment and procedures as those used in the extraction of other volatile oils with steam.

References.-

BACK, E. A., AND RABAK, FRANK.
1922. RED CEDAR CHESTS AS PROTECTORS AGAINST MOTH DAMAGE. U. S. Dept. Agr. Bul. 1051, 14 pp., illus.

HUDDLE, H. B.
1936. OIL OF TENNESSEE RED CEDAR. Ind. & Eng. Chem. 28: 18-21, illus.

CITRONELLA

Botanical Source.- *Cymbopogon nardus* (L.) Rendle, known in Ceylon as "Lenabatu" and *C. winterianus* Jowitt, known as "maha pengiri." Fam. Gramineae.

Range.- East Indies and southeastern Asia. Also under cultivation in Ceylon, East Africa, the West Indies, and in Central America, particularly in Guatemala.

Nature of Plants.- Tall perennial grasses.

Part Used.- Essential oil distilled from leaves.

Commercial Uses, Sources, and Importance.- Oil of citronella is used to a limited degree as an insect repellent. Its most important use is as a scenting material in soaps and perfumes. The oil is also used as a raw material for the synthesis of menthol. Geraniol, obtained from Java citronella oil, is used extensively in Japanese beetle traps as an attractant for the beetle.

Ceylon and Java are the largest producers of oil of citronella. Guatemala is the most important source of this oil in the Western Hemisphere. The Netherlands Indies and Ceylon are the principal sources of United States imports.

Imports of citronella oil into the United States, by countries of origin, 1938-40

COUNTRIES OF ORIGIN	1938		1939		1940	
	Pounds	*Dollars*	*Pounds*	*Dollars*	*Pounds*	*Dollars*
Ceylon	766,470	224,330	636,015	164,818	388,218	116,122
Guatemala	87,154	25,970	165,865	39,010	145,055	40,709
Netherlands Indies	1,156,093	363,796	1,942,260	452,125	2,369,412	543,592
Other countries	123	54	-	-	-	-
Total	2,009,840	614,150	2,744,140	655,953	2,902,685	700,423

The trade recognizes two types of Citronella oil: "Java" and "Ceylon." The trade names are derived from the fact that Java oil is obtained from *C. winterianus*, most of which is grown in Java, whereas Ceylon oil is obtained from *C. nardus*, cultivated mainly in Ceylon.

Propagation and Culture.- Java citronella oil is considered the best by the essential-oil trade because of its higher geraniol content. *C. winterianus* yields heavy crops and therefore requires fertile soils. *C. nardus*, on the other hand, is not such a heavy yielder and apparently does well on soils of low fertility. Both grasses prefer sandy loam or other loose soils which are friable and permit good drainage. The total weight of grass produced on these soils may not be so great as that obtained on heavier soils, but the percentage of oil is usually higher. In Java, citronella grows well from sea level to 2,000 feet. A mean annual temperature of 75° F. to 80° F. is desirable as well as a yearly rainfall of 80 to 100 inches so distributed that the dry season or seasons are not too long or severe. Shade reduces both rate of growth and oil content of the grass.

Both Java and Ceylon citronella are propagated with rooted crown divisions of mature grass that may be obtained by thinning out an old field. The clumps of rooted crowns are trimmed of all but 5 or 6 inches of their grass tops and dried slightly in the shade before planting. The slight drying lessens a subsequent loss of transplants from rotting. They are set out at intervals of 2 to 3 feet in rows 2 to 3 feet apart in the case of Java grass, which under good growing conditions is the more vigorous of the two types. The Ceylon type is the best to plant on soils of low fertility. On the Ceylon plantations, it is usually spaced at intervals of 1.5 feet in rows 1.5 feet apart.

Planting is done during the rainy season to avoid the killing of the transplants by drought. The field to be planted to citronella should be as free of weeds as possible. The ground may be either plowed or worked well with a mattock. The roots of the newly set plants are fixed firmly in the ground and well covered with soil. Citronella grass requires some weeding from time to time. The heavy yields of Java grass gradually exhaust the soil, and plantations are usually not profitable after 4 or 5 years. Ceylon grass plantations, on the other hand, are said to be profitably productive for 10 and even 15 years, although yields do not remain at a high level. In Java, when plantations become unprofitable, it has been found most economical to plow up the land and plant it to some perennial leguminous green-manure crop to restore fertility.

Harvest and Preparation for Market.- The first harvest of citronella grass may be made 6 to 10 months after planting, depending on how well established the plants have become. Subsequent harvests are made usually at intervals of 3 to 4 months, depending on the rapidity of growth. Cutting time is best determined by the condition and maturity of the grass. It should not be cut when too young and succulent nor should it be permitted to reach the flowering stage. Citronella can be cut either with mechanical mowers or by hand with sickles or machetes, but the latter is the almost universal custom.

Since citronella grass is dried before distillation, it is cut during periods of clear weather in the rainy season or even in the dry season, although cutting during the heat of the dry season is often detrimental to the plants. After cutting, the grass is allowed to dry in the field or is hauled to drying floors or sheds. During the drying-out process the heavy grass is occasionally turned to prevent fermentation. Old leaves and weeds are separated from the material before it is used for distillation. After distillation, the exhausted grass is used preferably as manure or as fuel for the stills. When the grass is used as fuel, the ashes should be saved and applied to the fields as fertilizer.

Yields.- The yields of citronella vary considerably, depending on variety, soil, and climate. Ceylon grass in Ceylon averages about 8 tons per acre annually. It contains about 0.4 percent of essential oil. Yields increase up to the third year and usually decline after the fifth.

In Java the Java grass averages 10 to 12 tons per acre annually, and it has an essential-oil content of about 0.7 percent. Yields are usually greatest during the second and third years and decline afterward.

References.-

GUENTHER, ERNEST S.
1940. CEYLON CITRONELLA. Soap and Sanit. Chem. v. 16, No. 9, 30-33, 75-76; No. 10, 32-35, 73-74, illus.

1942. JAVA CITRONELLA OIL. Soap and Sanit. Chem. v. 18, No. 2, 24-28, 69-70; No. 3, 25-28, 69-70; No. 4, 27-30, 69-70, illus.

DERRIS

Botanical Source.- *Derris elliptica* (Roxb.) Benth. and *D. malaccensis* (Benth.) Prain. Fam. Leguminosae. Two definite types or varieties of *D. elliptica;* namely, "Sarawak Creeping" and "Changi," and one principal variety of *D. malaccenis* named *sarawakensis* are the important sources of commercial derris root. A number of other species have been examined but found to be of comparatively little value.

Range.- Most of the tropical regions of eastern Asia and the East Indies.

Nature of Plants.- Perennial climbing shrubs.

Part Used.- Root.

Commercial Uses, Sources, and Importance.- Derris root, also known as tuba, is one of the most efficient insecticides of plant origin now in commercial use. Its insecticidal value is due principally to the presence of rotenone, which is extremely toxic to certain insects. It acts both as a contact and stomach poison. Rotenone is harmless to man in the quantities found as residues on crops sprayed with its compounds. Substances related to rotenone are also present in derris root and these, while less toxic than rotenone, add to the value of the root. Derris insecticide is applied as a dust made of ground root mixed with talc, or other inert materials, or as a spray. The sprays are compounded with extracts of the active principles taken from the crude roots. Some derris is used as a source of pure rotenone or the so-called "total extractives." These products are marketed in the form of various commercial preparations for a wide range of insecticidal use.

The principal countries of origin of commercial derris root are British Malaya, the Netherlands Indies, the Philippine Islands, and Indochina. Recent plantings have been made in Puerto Rico and in Central and South America.

Imports of derris root (crude) into the United States by countries of origin, 1938-40

COUNTRIES OF ORIGIN	1938		1939		1940	
	Pounds	*Dollars*	*Pounds*	*Dollars*	*Pounds*	*Dollars*
British Malaya	583,035	68,279	2,325,492	251,035	1,842,087	195,286
Netherlands Indies ...	136,235	21,617	262,445	38,230	996,845	132,430
Philippine Islands ...	23,391	3,263	228,632	20,360	229,465	17,520
French Indochina	-	-	33,069	3,968	143,911	13,968
British East Africa ..	-	-	-	-	8,664	1,368
Total	742,661	93,159	2,849,638	313,593	3,220,972	360,572

Imports of derris root (powdered) into the United States, by countries of origin, 1938-40

COUNTRIES OF ORIGIN	1938		1939		1940	
	Pounds	*Dollars*	*Pounds*	*Dollars*	*Pounds*	*Dollars*
United Kingdom	2,240	828	6,720	2,154	-	-
Philippine Islands ...	-	-	33,171	2,775	-	-
Netherlands Indies ...	-	-	18,032	5,095	-	-
Total	2,240	828	57,923	10,024	-	-

Propagation and Culture.- Derris is a tropical plant, which grows best on rich, well-drained soil of a sandy or sandy loam type. Most luxuriant growth is promoted by a well-distributed annual rainfall of at least 80 inches, preferably more. While vines are known to have survived light frosts, a tropical or subtropical climate is most suitable for commercial production. Successful plantings have been made at altitudes ranging from sea level up to 5,000 feet.

Derris is propagated by means of vine cuttings, which are usually obtained from fields of mature plants at the time the roots are harvested. Where a rapid increase of high-rotenone-yielding varieties is desired, the nursery vines may be supported on trellises. Trellising produces more rapid and more vigorous growth, resulting in the production of greater quantities of mature cutting material of larger diameter in a shorter period of time.

The practice considered the best is that of planting vine cuttings in nursery beds until they have developed roots. In Puerto Rico the nursery beds consist of flat-topped ridges thrown up by a lister plow in a field that has been previously well plowed and disked. The cuttings, which are about 10 to 12 inches in length, can be set in rows spaced 7 or 8 inches apart. Depending on their size, from 8 to 12 cuttings can be placed in a row. All propagating material should have mature bark and should be laid in the nursery-bed rows at a 45-degree angle and almost completely covered with soil. Rooting will be successful only during a rainy season. It will usually begin in 2 weeks when good planting stock is used and the ground is kept moist. Rooted cuttings may be removed to the field when they have been 2 months or more in the nursery bed.

A field in preparation for planting derris should be thoroughly plowed and disked. The rooted cuttings are most conveniently planted in furrows opened by a lister plow.

These furrows are usually spaced about 3 feet apart and are 3 to 4 inches deep. The rooted cuttings, which are trimmed of all but about 6 or 8 inches of leafless vine, are set horizontally in the trench every 2 or 3 feet. All the planting piece, except the short section of vine stem, is covered with earth by hoeing. The planting operation is more easily performed by men working in teams of two. The purpose of the horizontal placement is to encourage the development of a shallow root system which can be more easily harvested. Before derris vines have crossed over between the rows, machine cultivation may be practiced. Afterward hand weeding is necessary. In the Netherlands Indies, plantings of trellised derris have been established. While trellising increases yields, it also increases costs.

In some regions derris is grown as a cover crop on rubber plantations, where it is planted between young rubber trees. It is well adapted to this purpose, inasmuch as it is harvested in about 2 years and during the second year serves to control weeds.

Harvest and Preparation for Market.- Derris roots are usually harvested when the plants are about 2 years old. The age of harvest, however, may range from 14 to 36 months or more. In order to clear a field for digging out the roots, the mat of vines covering the ground must be removed. In Puerto Rico the vines are cut with machetes and removed from the fields in rolls.

Derris may be harvested most easily at any time during a dry season when the soil is moist enough to dig or plow. If propagating material is to be taken from the vines and no provision is made for irrigating the nursery beds, the derris should be harvested at the beginning of a rainy season before the soil is saturated and when reasonably good root-drying weather may still be expected. Harvesting is the most expensive of the various procedures necessary in the growing of derris.

After the vines are removed, the roots may be dug or plowed out. If plowed, laborers follow the newly turned furrows to fork over the loose earth and pull out the roots. When properly cared for on light soils, the derris root system may develop close to the surface of the ground. In such cases the plants may be lifted from the soil entire and the roots cut off. In harvesting trellised plantings one can plow or dig out only the lateral roots, leaving the plants in position to develop another crop. After gathering, the roots are collected into piles and carried away for drying either in the sun, in ventilated sheds, or in flue-heated drying chambers.

Parent cuttings are low in rotenone and are removed from the roots before they are dried. They may be used again as planting material. After a number of days, when the thickest of the roots are snap dry, all of them are packed into bales for shipping. Roots grown on heavy soil must be washed before drying in order to remove clods of earth. Sometimes roots are cut into sections 1 to 2 inches long before drying. These are sacked rather than baled for shipping.

Yields.- Yields depend on variety and growing conditions, but from 800 to 1,500 pounds of derris roots may usually be obtained from an acre of old plants from 2 to 2½ years old. The method of planting, whether as a full crop or interplanted with rubber or other trees; the age of the roots when taken up; the nature of the soil; species; and variety grown are all contributing factors. Commercially desirable root should have 5 percent or more of crude rotenone, based on the air-dry weight.

References.-

ADRIANO, F. T.
1934. THE CULTIVATION, TOXIC CONSTITUENTS, USES, CHEMICAL ANALYSIS AND EXTRACTION OF DERRIS. Philippine Jour. Agr. 5(1): 1-17, illus.

GRIST, D. H.
1935. DERRIS (TUBA ROOT). Malayan Agr. Jour. 23: 477-482.

LEGROS, J.
1937. CULTIVATION OF DERRIS IN THE FAR EAST. Internatl. Inst. Agr., Internatl. Rev. Agr. 28: 1T-12T, illus.

PUERTO RICO AGRICULTURAL EXPERIMENT STATION.
1939-41. P.R. Agr. Exp. Sta. Ann. Rpts. [1938-40] Mayagüez.

ROARK, R. C.
1932. A DIGEST OF THE LITERATURE OF DERRIS (DEGUELIA) SPECIES USED AS INSECTICIDES, 1749-1931. U.S. Dept. Agric. Misc. Pub. 120. 86 pp.

SIEVERS, A. F.
1939. THE PRODUCTION AND MARKETING OF DERRIS ROOT. U. S. Bur. Plant. Indus., 24 pp. [Mimeographed copy in U.S. Dept. of Agr. Library, Washington, D. C.]

HELLEBORE

Botanical Source.- *Veratrum viride* Aiton; *V. album* L. Fam. Liliaceae.

Range.- *V. viride:* The United States, particularly in the northeast.
V. album: Southern Europe and Siberia.

Nature of Plants.- Perennial herbs.

Parts Used.- Roots and rhizomes.

Commercial Uses, Sources, and Importance.- The ground roots and rhizomes of *V. viride*, American false hellebore, and *V. album*, white false hellebore, have been used to a limited extent as insecticides. They contain a number of poisonous alkaloids, which are of some medicinal value as well.

V. viride, which is native to the United States, is more commonly found in the Middle Atlantic States. Most of the root prepared for market comes from North Carolina, Virginia, Illinois, and Michigan.

V. album root is obtained from European and Siberian sources, but the trade in this product is not significant. In 1939 the United States imported 39,440 pounds valued at $1,639 from Yugoslavia, Belgium, France, and Italy.

Harvest and Preparation for Market.- The Commercial production of these plants in the United States is not recorded. It is assumed, therefore, that only the roots and rhizomes of wild plants found in swamps and lowlands are utilized. They may be propagated by seeds or rhizomes.

V. viride is one of the first swamp plants to begin growth in the spring. Its flowers appear in June. The rhizomes and attached roots are dug in the fall. After digging they are cut into pieces and dried. They are usually marketed in that crude form, although occasionally they are ground into a coarse powder.

References.-

BAILEY, L. H.
1935. THE STANDARD CYCLOPEDIA OF HORTICULTURE... Rev. ed., 6 V., illus. The MacMillan Co., New York.

HOLM, THEO.
1915. MEDICINAL PLANTS OF NORTH AMERICA - VERATRUM VIRIDE. Merck's. Rpt. 24: 109-111, illus.

LLOYD, JOHN URI.
1897. VERATRUM VIRIDE. West Drug. 19: 447-449, illus.

LARKSPUR

Botanical Source.-*Delphinium colsolida* L. and other species of *Delphinium.* Fam. Ranunculaceae.

Range.- *D. consolida* is native to southern Europe, but it has long been cultivated in the United States and elsewhere as an ornamental.

Nature of Plant.- *D. consolida,* herbaceous annual.

Part Used.- Seed.

Commercial Uses, Sources, and Importance.- The ground seed of *D. consolida* and a number of other delphiniums has been used to a limited degree for the control of head lice. Certain delphinium alkaloids are toxic as stomach poisons to a number of insects. They are also poisonous to human beings. The commercial exploitation of delphinium seeds as insecticides is not significant.

Propagation and Culture.- The ease with which annual larkspurs can be grown is well known. A rich well-drained sandy or gravelly soil is desirable for *D. consolida.* The location selected should not be shaded. The climate may be relatively dry. The plants do not bear transplanting well; therefore seeds should be sown where the plants are to stand. Planting may be done in the early fall or preferably in the spring. The ground should be well plowed and harrowed. The seeds may be sown with a drill in rows from 2 to 3 feet apart. When up, the plants should be thinned to stand from 8 to 12 inches apart in the rows. Necessary cultivation consists of keeping the soil free from weeds during the growing season.

Harvest and Preparation for Market.- When the seed capsules are fairly ripe, the seed is harvested by collecting the tops, which should be cut before the seed capsules have become so brittle as to risk loss of seed by shattering. They can be handled best in the early morning while damp and pliable. The capsules should be cured in well-ventilated shelters, where they are protected from rain. When well dried the seeds may be beaten out of the capsules, cleaned, and sacked for market.

Reference.-

STOCKBERGER, W. W.
1935. DRUG PLANTS UNDER CULTIVATION. U. S. Dept. Agr., Farmers Bul. 663, 38 pp., illus. [Revised.]

LONCHOCARPUS

Botanical Source.- *Lonchocarpus urucu* Killip & Smith; *L. utilis* A. C. Smith and other species of *Lonchocarpus;* Fam. Leguminosae.

Range.- South American tropics.

Nature of Plants.- Perennial vinelike shrubs or small trees.

Part Used.- Roots.

Commercial Uses, Sources, and Importance.- The roots of the commercially important species of *Lonchocarpus* variously known as cubé, timbó, barbasco, haiari, and nekoe contain the insecticide rotenone. (For details on the properties of rotenone and its related compounds, see section on Derris.) When dried and finely ground, they are usually mixed with talc or other finely divided material and used as insecticidal dusts to combat certain garden, field, orchard, and household insect pests. The expressed juice of fresh roots diluted with water is used on some agricultural pests in the regions where lonchocarpus is grown. Extracts of lonchocarpus roots are employed in certain insect sprays. Flea powders and stock-dip preparations are compounded from them. In addition to its insecticidal properties, rotenone is a powerful fish poison. Lonchocarpus roots were first employed for this purpose before their insecticidal value was realized.

Peru, Brazil, and Venezuela have been the primary sources of the world's supply of lonchocarpus roots. Commercial plantations have recently been made in other countries of the Western Hemisphere tropics. United States imports in recent years originated largely in Brazil and Peru.

Imports of lonchocarpus into the United States by countries of origin, 1938-40

COUNTRIES OF ORIGIN	1938		1939		1940	
Crude root:	*Pounds*	*Dollars*	*Pounds*	*Dollars*	*Pounds*	*Dollars*
Brazil	58,979	2,879	146,365	9,477	387,413	28,580
Peru	476,760	32,777	1,730,023	135,412	2,225,347	185,840
Venezuela	55,115	8,167	170,230	23,104	74,163	10,546
Total	590,854	43,823	2,046,618	167,993	2,686,923	224,966
Root powder:						
Brazil	1,733,755	245,391	954,531	122,660	658,920	85,896
Grand total	2,324,609	289,214	3,001,149	290,653	3,345,843	310,862

Propagation and Culture.- The commercial species of *Lonchocarpus* grow best on rich, well-drained, sandy or sandy clay loam soils containing considerable humus. They do not do well on lands that are occasionally flooded or that have high water tables. A fairly well distributed annual rainfall of at least 80 inches prevails in the principal growing regions of South America. *Lonchocarpus* is frequently favored by cloudy weather much of the day in the regions where it is native. The plant is known to have survived frosts, but it is not grown on a commercial scale, except in tropical climates.

The plant is propagated by stem cuttings that have several nodes and are about 12 or 18 inches in length. It is the usual practice to set the cuttings directly in the field at distances of 3 by 6, or 6 by 6 feet. The closer planting is convenient, when one does not expect to replant cuttings that do not survive. A cutting mortality up to 50 percent is not unusual. The wide spacing is more convenient when replanting is anticipated and when one may desire to interplant the lonchocarpus the first year with such a crop as corn or cassava. Shading by interplanted crops has been reported to aid the young sprouting cuttings, although such shade is undesirable for established plants. Planting is done during the rainy season to avoid the drying out of cuttings that develop roots slowly. Cuttings are placed in the ground at an angle of from 30 to 45 degrees and in such a way as to leave only a small tip exposed or just barely covered with soil.

The cultivated crop usually requires 3 years or more before it is ready to harvest. The plants grow at a rate varying from 2 to 6 feet a year. *L. urucu* plants have a decumbent habit of growth. *L. utilis* plants are usually erect up to the time they are ready for harvest. The latter are easier to weed, and the tops are removed from the fields at harvesttime with less difficulty. Although *L. utilis* is reported generally to have roots of a higher rotenone content than *L. urucu*, the latter is reported to produce a greater quantity of root than the former in an equal period of growing time.

Harvest and Preparation for Market.- Lonchocarpus roots are usually harvested after 3 years' growth. They may be gathered at any season of the year. During the rainy season they are more easily dug, but during the dry season they are more easily dried for market. The aerial portions of the plant are cut off close to the surface of the ground and removed so they will not interfere with the digging of the roots. If propagating material is desired, it is obtained at this time and should be planted quickly before having a chance to dry out. The roots, which are long, large, and tough, spread out laterally close to the surface of the ground. They are removed one at a time by a series of operations, which begins by locating each root with a mattock and severing it from the trunk with the same tool. The actual process of removing the roots from the ground consists of alternately pulling on the root and, as the direction in which it runs is determined, of digging with a mattock to facilitate the pulling. A man experienced in pulling lonchocarpus roots is able to harvest the equivalent of 50 to 75 pounds of air-dry roots a day.

After digging, the roots should be carefully washed and dried. The drying may be done in the sun or in ventilated sheds. It is facilitated by tearing longitudinally in long strips. When the largest are snap dry, the roots are packed into bales for shipment.

Yields.- Yields of 1,500 to 2,500 pounds or more of air-dry roots per acre are usually obtained from fields of plants 2 to 3 years old. Commercially desirable roots should have a 5-percent or higher crude-rotenone content, based on their air-dry weight.

References.-

[Great Britain] Imperial Institute.
1938. THE CULTIVATION OF LONCHOCARPUS. [Gt. Brit.] Imp. Inst. Bul. 36(2): 179-185. London.

Legros, J.
1939. SOME LONCHOCARPUS SPECIES, ROTENONE YIELDING PLANTS OF SOUTH AMERICA. Internatl. Rev. of Agr. 30: 11T-29T, 51T-61T.

Roark, R. C.
1936. LONCHOCARPUS SPECIES (BARBASCO, CUBE, HAIARI, NEKOE AND TIMBO) USED AS INSECTICIDES. U. S. Bur. Ent. & Plant. Quar. E-367, 133 pp. [Mimeographed.]

----- 1938. LONCHOCARPUS (BARBASCO, CUBE, AND TIMBO) A REVIEW OF RECENT LITERATURE. U. S. Bur. Ent. & Plant Quar. E-453, 174 pp. [Mimeographed.]

Wille, J. E., Ocampo, J. A., Wéberbauer, A., and Schofield, Q. D.
1939. EL CUBE (LONCHOCARPUS UTILIS) Y OTROS BARBASCOS EN EL PERU. Ed. 2, corr. No. 11, 1937. Bol. Estad. Expt. Agr., La Molina, No. 16, 129 pp., illus. Lima.

PYRETHRUM

Botanical Sources.- *Chrysanthemum cinerariaefolium* (Trev.) Vis.; *C. coccineum* Willd. Fam. Asteraceae.

Range.- *C. cinerariaefolium* (Dalmatian pyrethrum): Indigenous to Yugoslavia and cultivated there and in Kenya, Japan, and in a limited way in other countries, including the United States and Brazil.

C. coccineum (Persian pyrethrum): Indigenous to the Caucasus and northern Iran. Its cultivation is not commercially important.

Nature of Plants.- Herbaceous perennials.

Part Used.- Partially and fully opened flower heads.

Commercial Uses, Sources, and Importance.- Pyrethrum is one of the oldest and most widely used of the insecticides derived from plants. The dry pulverized flowers, known as "insect powder," have long been used for household purposes for controlling flies, cockroaches, ants, bedbugs, and other insects. Extracts of pyrethrum find application in spray form in the control of mosquitoes and flies. In both forms pyrethrum is used commercially in greenhouses and gardens. Because it is nonpoisonous to man and animal, it may be safely used under all conditions.

The effectiveness of pyrethrum sprays is greatly increased by the addition of sesame oil as a synergist. This oil is obtained from the seed of *Sesamum indicum* (L.). Pyrethrum extractives are used in an effective delousing preparation.

From about 1860 until the first World War, the pyrethrum used in the United States was imported from Dalmatia. When this source of supply was cut off in 1914, Japan began to expand the cultivation of the crop which was first introduced into that country in 1881. Within 10 years, from 80 to 90 percent of the United States imports were obtained from Japan. In more recent years the crop was successfully introduced into Kenya, Africa, where a high grade of flowers is now produced. Kenya is at present the principal source of imports by the United States. Pyrethrum has also been grown commercially in Brazil. In the United States the crop has never become permanently established. Many years ago it was grown in California. More recently several hundred acres were planted in Pennsylvania, but the crop was not economically successful, although high yields were obtained. At present there are only small acreages in southwestern Colorado and southern California.

Imports of pyrethrum, crude, into the United States, by countries of origin, 1938-40

COUNTRIES OF ORIGIN	1938		1939		1940	
	Pounds	*Dollars*	*Pounds*	*Dollars*	*Pounds*	*Dollars*
Belgian Congo	-	-	2,205	625	16,965	5,384
Brazil	497,166	65,874	79,775	9,989	78,408	12,868
British East Africa	2,864,205	618,653	5,524,120	1,465,802	10,386,974	2,512,517
Italy	28,474	2,031	78,409	9,173	10,853	1,360
Japan	10,895,604	1,781,043	7,485,587	1,636,193	2,030,746	408,621
Peru	-	-	-	-	1,122	172
United Kingdom	33,600	4,914	11,038	1,076	-	-
Yugoslavia	218,368	18,355	388,166	50,746	66,142	8,289
Total	14,537,417	2,490,870	13,569,300	3,173,604	12,591,210	2,949,211

Cultivation and Propagation.- Pyrethrum requires a well-drained soil. It grows best on a sandy loam but has also been successfully grown on clay. The plant will survive low winter temperatures, particularly when protected by snow, and will withstand considerable drought, although lack of adequate rainfall during the spring and early summer will greatly reduce the yield of flowers. Alternating extremes of temperature, causing freezing and thawing of the ground, is frequently damaging. The belief is general that at high altitudes the yield of flowers is less but their toxicity is greater. Extensive experiments in the United States by various agencies appear to have demonstrated that the crop is better adapted to the northern than to the southern States and that it will do well in some of the irrigated districts in the West. In Kenya, Africa, it is grown on a high plateau near the Equator where, due to the altitude, the climate is quite temperate. In Japan the crop was first grown on the poor soils of the mountain slopes of the northern island of Hokkaido, but more recently much of the production has been in certain Prefectures of the main island, Honshu, where the soil is more fertile, the rainfall heavier, and the temperatures milder.

Pyrethrum is ordinarily grown from seed, which is usually sown in seedbeds, the seedlings being transplanted to the field when 5 to 6 weeks old. Direct field sowing is not practical in most localities but is reported to be successfully employed in several districts in western United States. The seedbeds are planted in early spring, and, when the seedlings are from 3 to 5 inches high, they are transplanted to the field. They are spaced from 12 to 18 inches apart in rows 3 feet apart, or in check rows 2 feet apart in each direction, depending on local conditions, fertility of the soil, etc. Planting is done by hand or with transplanters, such as are used for other crops. Seed may also be sown in seedbeds in the fall for transplanting the following spring.

The seedlings become established rather easily, and by fall the plants usually have a crown diameter of 6 inches or more. No crop of flowers is obtained the first year. The following summer a fair crop of flowers is gathered in the period May to July or August, the exact blossom time depending upon the latitude and altitude. In Kenya flowers are produced more or less throughout the year. The plant may also be propagated by crown division.

Pyrethrum is subject to damage by a number of leaf, crown, and root diseases.

Harvesting and Preparation for Market.- In order to obtain the flowers at the stage of maximum toxicity, they are harvested before they begin to ripen, when most of them are from two-thirds to fully open. Except in the United States, they are usually picked by hand or stripped by crude hand-operated stripping devices. In some places the plants are cut off with sickles and the flowers later removed by drawing the flower stalks through a comblike stripper attached to a bench. All these methods require much hand work and are only feasible in regions where labor is cheap. In the United States mechanical devices have been tried. The most successful and the most economically operated of these is a team- or tractor-drawn machine that passes over the plants, removes the flowers with stripping rolls, and deposits them in a hopper in the rear. This machine can harvest the crop at the rate of about 4 or 5 acres a day under favorable conditions.

Immediately after harvesting, the flowers must be spread out to dry. In regions where clear weather prevails this may be done in the open as in Japan, where they are spread thinly on straw mats. Elsewhere provision must be made for indoor drying. Because the flower crop must be harvested within a few days if the best quality of pyrethrum powder is desired, much space must be provided for the drying operation. In the United States, drying on trays in heated rooms or chambers, or in other types of rapid driers, has been found to be the most dependable way for handling commercial crops.

In the commercial producing regions the dry flowers are packed under high pressure into bales for shipment. Proper storage of the flowers, whether baled or otherwise, is necessary to prevent deterioration, which takes place rapidly.

Yields.- After the second year, when the first small crop is obtained, crops may be produced for several years, depending on the general condition of the plants. In Japan, the average annual yield of dry flowers reported in Hokkaido over an 18-year period was 350 pounds. Commercial plantings in the United States, particularly in Pennsylvania, have yielded up to 1,000 pounds per acre with an average of 700 to 800 pounds. At higher altitudes in Colorado the yield is substantially less.

References.-

CULBERTSON, R. E.
1935. PYRETHRUM - A NEW CROP FOR PENNSYLVANIA. Pa. Farmer. 112: 5, 18-19, illus.

DRAIN, BROOKS D.
1936. PYRETHRUM IN TENNESSEE. Tenn. Agr. Expt. Sta. Circ. 59, 4 pp., illus.

Gnadinger, C. B.
1936. PYRETHRUM FLOWERS. 2d. ed. 380 pp., illus. McLaughlin Gormley King Co., Minneapolis, Minn.

_____, Evans, L. E., and Corl, C. S.
1936. PYRETHRUM PLANT INVESTIGATIONS IN COLORADO. Colo. Expt. Sta. Bul. 428, 29 pp., illus.

Julliet, A.
1924. LE PYRETHRE INSECTICIDE DE DALMATIE. ORIGINE, CULTURE, PRINCIPES ACTIFS, APPLICATIONS A L'AGRICULTURE. Min. du Com. et de l'Indus... 236 pp., illus.

McDonnell, C. C., Roark, R. C., and Keenan, G. L.
1920. INSECT POWDER. U. S. Dept. Agr. Bul. 824, 100 pp., illus.

Sievers, A. F.
1940. PYRETHRUM: ITS CULTURE AND POSSIBILITIES AS A CROP IN THE UNITED STATES. U. S. Bur. Plant Indus. 7 pp., illus. [Mimeographed.]

_____, Lowman, M. S., and Hurst, W. M.
1941. HARVESTING PYRETHRUM. U. S. Dept. Agr. Cir. No. 581, 28 pp., illus.

QUASSIA

Botanical Source.- *Aeschrion excelsa* (Sw.) Kuntze; *Quassia amara* L. and other species. Fam. Simarubaceae.

Range.- *A. excelsa*, Jamaica and the Dominican Republic; *Q. amara*, tropical northern South America.

Nature of Plants.- *A. excelsa*, tall tree. *Q. amara*, small shrublike tree.

Part Used.- The wood.

Commercial Uses, Sources, and Importance.- The use of quassia as an insecticide has been limited to the control of aphids, particularly the hop aphid. The imports into the United States are mainly derived from *A. excelsa* and probably other species of this genus known as Jamaica quassia from Jamaica and other Caribbean Islands, and from *Q. amara*, obtained mostly from Surinam and known in the trade as Surinam quassia. In 1939 the quantity imported by the United States amounted to 291,325 pounds, valued at $3,742. Jamaica was the principal source of these imports. Quassia is used to a limited extent in medicine, but it is not known how much of the quantity imported is diverted to that use.

Harvest and Preparation for Market.- All supplies of quassia are obtained from native trees, there being no commercial cultivation of the species. Information on the methods of harvesting and handling the wood in preparation for the market is lacking. Reports indicate that much of it arrives in the United States in the form of chips or shavings, but some coming via European ports is received in irregular cubes. According to one report, it is also received from Jamaica in the form of logs, which are made into medicinal drinking cups. The waste chips, etc., then go into the drug or insecticide trade.

References.-

Busbey, R. L.
1939. A BIBLIOGRAPHY OF QUASSIA. U.S.Bur. Ent. &Plant. Quar. E-483, 56 pp. [Mimeographed.]

Culbreth, David M. R.
1900. A MANUAL OF MATERIA MEDICA AND PHARMACOLOGY...Ed. 2, enlarged and revised. 885 pp., illus. Lea Brothers and Co., Philadelphia and New York.

McIndoo, N. E., and Sievers, A. F.
1917. QUASSIA EXTRACT AS A CONTACT INSECTICIDE. Jour. Agr. Res. 10: 497-531, illus.

[Wood, George Bacon.]
[1937.] THE DISPENSATORY OF THE UNITED STATES OF AMERICA. Centennial (22d) ed., rev. and largely rewritten by Horatio C. Wood, Jr., Charles H. LaWall. and others, 1894 pp., illus. J. B. Lippincott Co., Philadelphia and London.

SABADILLA

Botanical Source.- *Schoenocaulon officinale* (Schlecht.) A. Gray. Fam. Liliaceae.

Range.- Mexico, Guatemala, Venezuela.

Nature of Plant.- Herbaceous perennial.

Part Used.- Seed.

Commercial Uses, Sources, and Importance.- Sabadilla seed (also known as cevadilla) is used in the control of head lice. Its usefulness for this purpose seems to have been known for a long time. It is also reported to be successfully used as an insecticide by cattle raisers in Venezuela. Experimenters have stated that the finely powdered seed (after removal of the oil) is effective against grasshoppers, roaches, webworms, and chicken lice but without effect on five species of aphids. Its relatively minor importance in the United States is indicated by the limited imports, which in 1939 came entirely from Venezuela and amounted to 93,977 pounds valued at $10,142. The seed has pronounced physiological properties due to the presence of several powerful alkaloids, which are extracted from it, but the seed itself is seldom used in any form medicinally.

Harvesting and Preparation for Market.- The sabadilla seed entering the trade is probably largely obtained from wild plants, although the plant is reported to be under cultivation. No reliable information is available concerning the commercial culture of the plant or the method of harvesting the seed and preparing it for the market.

References.-

McIndoo, N. E., and Sievers, A. F.
1924. PLANTS TESTED FOR OR REPORTED TO POSSESS INSECTICIDAL PROPERTIES. U. S. Dept. Agr. Bul. 1201, 66 pp.

[Wood, George Bacon.]
[1937.] THE DISPENSATORY OF THE UNITED STATES OF AMERICA. Centennial (22d) ed., rev. and largely rewritten by Horatio C. Wood, Jr., Charles H. LaWall, and others. 1894 pp., illus. J. B. Lippincott Co., Philadelphia and London.

TOBACCO

Botanical Source.- *Nicotiana tabacum* L., *N. rustica* L., *N. glauca* Graham. Fam. Solanaceae.

Range.- *N. tabacum* is native to either Central or South America but has been naturalized in the United States and is widely cultivated throughout the temperate and tropical regions of the world. *N. rustica* is native to Mexico but has also been naturalized in the United States. *N. glauca* is native to South America but grows wild also in southern United States.

Nature of Plants.- *N. tabacum* and *N. rustica*: Annuals. *N. glauca:* Shrubby perennial.

Parts Used.- Leaves and stems and the alkaloids, nicotine, and anabasine obtained from them.

Commercial Uses, Sources, and Importance.- The principal active insecticidal constituent of the leaves and stems of *N. tabacum* and *N. rustica* is the alkaloid nicotine. That of *N. glauca* is anabasine. Nicotine has long been one of the most important commercial contact insecticides. It is usually applied in the form of nicotine sulfate in sprays and dips. Tobacco leaves and stems containing nicotine are also used as fumigants. Anabasine is a contact insecticide of the same empirical formula as nicotine and in many respects similar to it as an insecticide. Nornicotine, a related alkaloid, is reported to predominate in certain tobaccos.

N. tabacum is of course cultivated almost exclusively for smoking and chewing purposes. The normal annual consumption of nicotine for insecticidal use in the United States is approximately 1,000,000 pounds, which is used chiefly in the form of nicotine sulfate. The usual source of this is the waste tobacco that originates in connection with the marketing of the crop and the manufacture of cigars, cigarettes, snuff, and smoking and chewing tobacco. It consists of (1) the so-called scrap tobacco, which includes leaf trimmings or clippings and broken leaf, and (2) large quantities of stems. The stems constitute the bulk of the raw material for nicotine manufacture, but they contain much less nicotine than the scrap. In recent years an additional, important source of nicotine has been the lower-grade leaf of the dark fire-cured and air-cured types, which have been diverted from ordinary marketing channels.

Propagation and Culture.- The varieties and strains of *N. tabacum* grown under cultivation for the tobacco industry ordinarily do not contain sufficient nicotine to make it economically feasible to grow them exclusively as a source of nicotine for the insecticide industry. For that purpose varieties of much higher nicotine content must be grown; and so far, in the United States at least, even these have not been found sufficiently profitable at the prevailing price of nicotine sulfate. Common tobacco is so widely grown that its culture need not be discussed here. *N. rustica* is a plant somewhat similar to *N. tabacum*, and its cultural requirements and methods of handling are much the same as for the latter species. Selected strains of *N. rustica* in Kenya, Africa, are reported to contain as much as 14 percent nicotine. Investigation of the possibilities of this species has been made in various sections of the United States. The largest plantings of *N. rustica* have been made in the Soviet Union and India.

Methods of cultivating *N. glauca* are still in the experimental stage. The plant is native to the semiarid southwestern section of the United States and northern Mexico, but it is grown more satisfactorily under less rigorous climatic conditions. It is favored by an annual rainfall of from 30 to 40 inches and grows best on rich loam soils. The plant is a perennial where it is not killed by frost.

The present experimental methods of growing *N. glauca* are variations of those used in growing *N. tabacum;* the seed is germinated in carefully prepared seed beds, preferably steam-sterilized to prevent weed competition. Germination in greenhouses is preferred if such facilities are available, since the seedlings are tender and much care must be exercised with them. They are particularly susceptible to damping-off. Moss seedling beds kept moist by subirrigation are said to be satisfactory. When from 6 to 8 weeks old the seedlings are transplanted to a field previously well plowed, disked, and harrowed. The young plants may be spaced at distances of 18 inches in rows 3 feet apart.

Harvest and Preparation for Market.- The commercial harvesting, curing, and marketing of *N. tabacum* is well understood and, as in the case of its culture, need not be discussed here. In the east central United States where *N. glauca* has been grown experimentally, it must be treated as an annual, since it is killed by frosts. It is harvested like commercial tobacco and similarly dried in ventilated sheds. From the dry material thus obtained, anabasine sulfate is extracted.

Yields.- *N. rustica:* under favorable conditions plantings of selected strains of this species have consistently produced at the rate of 150 pounds of nicotine per acre in a number of localities in the United States. At this rate production is feasible but does not provide a wide margin of profit.

References.-

MARKWOOD, L. N.
1940. NORNICOTINE AS THE PREDOMINATING ALKALOID IN CERTAIN TOBACCOS. Science (n.s.) 92: 204-205.

MCMURTREY, JR., J. E., BACON, C. W., AND READY, D.
1942. GROWING TOBACCO AS A SOURCE OF NICOTINE. U. S. Dept. Agr. Tech. Bul. 820. 39 pp., illus.

MCINDOO, N. E., ROARK, R. C., AND BUSBEY, R. L.
1936. A BIBLIOGRAPHY OF NICOTINE. PART II, THE INSECTICIDAL USES OF NICOTINE AND TOBACCO. U. S. Bur. Ent. and Plant Quar. E-392, 628 pp. [Mimeographed.]

VETIVER

Botanical Source.- *Vetiveria zizanioides* (L.) Nash. Fam. Gramineae.

Range.- India, Malaya, Ceylon, East Indies, and the Philippines. It is also under cultivation in Réunion, the West Indies, and the United States.

Parts Used.- Roots and essential oil distilled from them.

Nature of Plant.- Perennial grass.

Commercial Uses, Sources, and Importance.- The root has been used since ancient times for scenting rooms, clothing, wardrobes, etc. It has long been popularly believed to be of use in repelling clothes moths. To some extent its use has no doubt been based on that assumption, but no reliable experimental evidence has been recorded of the efficacy of the root or the oil it contains for that purpose. The oil is of importance in the compounding of perfumes. The largest plantations of vetiver are in Reunion and Java. In Java the production of root is estimated at about 1,500 tons annually. Vetiver is grown to a limited extent in southern Louisiana, where the roots are sold locally.

Imports of oil of vetiver into the United States, by countries of origin, 1938-40

COUNTRIES OF ORIGIN	1938		1939		1940	
	Pounds	*Dollars*	*Pounds*	*Dollars*	*Pounds*	*Dollars*
United Kingdom	-	-	293	3,207	-	-
France and French Africa[1]	3,929	19,056	5,543	20,312	6,293	22,622
Netherlands and Netherlands Indies[2]	2,157	6,301	12,370	25,608	22,598	55,329
Other countries	-	-	-	-	1	6
Total	6,086	25,357	18,206	49,127	28,892	77,957

[1] Principally from root grown in Réunion.
[2] Principally from root grown in Java.

Propagation and Culture.- It is best to plant vetiver on rich loose soil, such as volcanic ash, because of the ease with which the mass of fibrous roots may be dug and separated from the earth at harvesttime. The oil content of the roots is reported to be less when the plant is grown on heavy-textured or infertile soils.

Although vetiver can withstand frost and low rainfall, its growth is favored by a yearly rainfall of from 80 to 100 inches and a mean annual temperature of from 70° to 80° F.

The plant is propagated by rooted crown divisions, which are set in well-tilled fields during the rainy season. They are obtained from the plants of old fields at harvesttime. The spacing of the plants in the field varies. In Reunion the usual practice is to space them about a food apart in each direction. This crowds the plants but facilitates removing the roots later. In Java from two to three times as much space is provided between the plants. The new plants become established easily, and the grass grows rapidly. The grass tops acquire a considerable diameter and soon cover the field, thus to a large extent controlling the growth of weeds.

Harvest and Preparation for Market.- In most places where vetiver has been grown for the production of essential oil, it has been found that the roots of 2-year-old plants contain the highest quality of oil, although the yield may not be so high as that from somewhat younger roots. The percentage of oil in the roots reaches a maximum at about 1 year or 15 months and declines considerably after 2 years.

Vetiver is harvested usually by pulling the plants out of the ground. The root clumps are then beaten to remove as much soil as possible. The roots are cut from the crowns and removed from the field for washing, after which they are dried either in the sun or in the shade. On the small acreages grown in Louisiana, the tops are first cut and the plants then pulled or plowed out of the ground.

The harvesting of vetiver is preferably done in the dry season, because then the dirt is more easily removed from the roots, and they dry more readily after washing. However, if one desires to use the old plants for setting out new fields, they must be harvested during the rainy season to assure good growing weather for the new plantings.

After the vetiver root is dried, it is subjected to distillation. The distillation of oil of vetiver is difficult, and only good steam-pressure equipment will produce a high-quality oil. Roots used for scenting material may be tied in small bunches and hung in closets on a string, or sachet bags may be made.

Yields.- Plantations 2 years old will yield about 2,000 pounds of dried root per acre. The yield of oil from the root ranges from 0.6 to 1.2 percent in Reunion and 1.5 to 2.0 percent in Java, the difference being due largely to the better equipment used in the latter country.

References.-

GUENTHER, ERNEST.
1938. RÉUNION OIL OF VETIVER. Drug and Cosmetic Indus. 43(4): 416-419, 422, 447, illus.

1939. OIL OF VETIVER, JAVA. Drug and Cosmetic Indus. 44(6): 710-712, 728, 732, illus.

RODENTICIDE PLANTS

NUX VOMICA

Botanical Source.- *Strychnos nux-vomica* L. Fam. Loganiaceae.

Habitat.- Ceylon, Indochina, East Indies.

Nature of Plant.- Tree.

Part Used.- The alkaloid strychnine obtained from the seed.

Commercial Uses, Sources, and Importance.- In the United States strychnine is an important agent for the control of field rodents, such as ground squirrels, prairie dogs, and kangaroo rats. For this purpose about 350,000 ounces are used annually by government rodent-control agencies and their cooperators. No definite figures are available regarding the amount similarly used by individuals or private agencies. Strychnine and the nux vomica seed are also used to an important extent for medicinal use.

Imports of nux vomica into the United States, by countries of origin, 1938-40

COUNTRIES OF ORIGIN	1938		1939		1940	
	Pounds	*Dollars*	*Pounds*	*Dollars*	*Pounds*	*Dollars*
French Indochina	66,202	1,842	1,368,599	36,913	1,179,605	28,526
British India	1,017,128	14,704	1,089,448	12,739	2,288,224	33,561
Total	1,083,330	16,546	2,458,047	49,652	3,467,829	62,087

Harvest and Preparation for Market.- Nux vomica seed are gathered from wild trees, growing from 40 to 50 and even 100 feet tall. These have been able to supply all this product that the market has demanded.

Getting the seed is a spare-time enterprise for the natives of the regions where the trees grow. In India they go into the forests during the summer rainy season when the fruit ripens. The bright brownish-yellow fruit is about the size of an orange. It contains a gelatinous pulp, in which are embedded a small number of thin buttonlike seeds about an inch in diameter. The seeds are separated from the pulp, washed, and dried in the sun. They are sold by the natives to small merchants, who accumulate sufficient quantities to market to exporters. After they are graded by the exporters to eliminate broken and light-weight seeds, they are put in bags for shipping.

Reference.-

UNITED STATES BUREAU OF MANUFACTURES.
1911. PRODUCTION OF STRYCHNINE AND NUX VOMICA. U. S. Dept. Com. and Labor Daily Cons. and Trade Rpts. No. 246, 350-352.

SQUILL (RED)

Botanical Source.- *Urginea maritima* (L.) Baker. Fam. Liliaceae.

Range.- Countries bordering on the Mediterranean from Spain to Palestine.

Nature of Plant.- Bulbous perennial.

Commercial Uses, Sources, and Importance.- Red squill, commonly known as the "sea onion," is a variety of the plant that also produces the white squill used in medicine. Red squill is one of the most efficient and potent raticides in commercial use. It is specific in its effects on rodents, being relatively harmless to other animals and man. The United States imports on the average about half a million pounds of red squill annually from Italy, Algeria, and France.

Harvest and Preparation for Market.- The plant grows wild on the sandy shores of the Mediterranean Sea in regions where the mean annual temperature is about 60° F. and the yearly rainfall ranges from 20 to 25 inches. Red squill matures slowly when grown from seed. Five to 6 years are required to produce bulbs of from 3 to 5 pounds, the most suitable market size. When propagated with sections of mature bulbs, the time required is lessened by a year or more.

Red-squill bulbs are reported to be more toxic when gathered in early summer during the middle of the growing season, but the usual custom is to harvest them in the early fall when their leaves have withered. At harvesttime the bulbs are pulled from the ground, and their tops and roots removed. They are ordinarily exported to the United States in this form.

The bulbs, before being ground into a raticide powder, are dried either in the sun or in ovens. Oven-drying is said to cause less loss of toxicity than sun-drying. Before the drying process is carried out, the outer leaves are removed from the bulbs, which are sliced into sections.

Reference.-

MUNCH, J. C., SILVER, JAMES, AND HORN, E. E.
1929. RED-SQUILL POWDERS AS RATICIDES. U. S. Dept. Agr. Tech. Bul. No. 134. 36 pp.

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